U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT

HEARING CHARTER

Declining Polar Bears and Permafrost: Is a Global Warming Tipping Point Embedded in the Ice?

Wednesday, October 17, 2007
10:00 AM - 12:00 P.M.
2318 Rayburn House Office Building

Purpose:

On Wednesday, October 17, 2007, the Investigations and Oversight Subcommittee will hold a hearing on the impacts of global warming on the Arctic. This hearing will provide the Committee with an opportunity to hear from witnesses on three interrelated matters: (1) the current situation in the Arctic, including the situation facing the polar bear, (2) ways in which warming in the Arctic may accelerate global warming, especially through the emission of more greenhouse gases, and (3) interim steps that could be taken to reduce greenhouse gas emissions while the Congress weighs more elaborate carbon trade or tax proposals.

One of the themes that should emerge from this hearing is that, from a layman's perspective, the models used to project climate change and its ramifications appear to be conservative in their projections. This is because any phenomena that are not understood well enough to be represented in models with confidence are excluded. These other phenomena may accentuate or depress warming trends. In the case of the Arctic, most of the phenomena that have been excluded from the models are believed to accentuate warming and its effects. Few will depress it. The modeling on polar bear survival, for example, uses projections from the IPCC models to estimate future changes in sea ice extent. Since the bears' condition is very dependent upon both the extent of the sea ice and the duration of ice-free periods, projections of the bear survival are very dependent upon projections of sea ice. This summer the sea ice extent is far less than projected by the models.

Some important factors that induce additional warming are either left out of IPCC models or are not fully accounted for, and therefore the actual decrease in sea ice extent could be significantly greater than the IPCC projections. For example, the IPCC modeling fails to include positive feedbacks from permafrost thawing which could add millions—even billions—of metric tons of greenhouse gases to the environment. Projections of sea level rise in the IPCC exercise do not include any run-off from melting ice sheets in Greenland

or Antarctica because the physical dynamics of that process are so poorly understood. The result is that as disturbing as the polar bear study is or as worrisome as the IPCC reports are, they probably minimize the global warming path we are on and the consequences we will live through as a result of that warming.

Recent Global Warming Reports Related to the Arctic

The past twelve months have seen two remarkable stories related to the Arctic. In January of 2007, the Department of the Interior proposed to list the Polar Bear as an endangered species. This proposal came in response to a successful lawsuit brought by the Center for Biological Diversity, which charged that the decline in the bear's habitat—a direct consequence of global warming—justified a listing. Subsequent information developed by the US Geological Survey (USGS) provides ample reason to believe that the bear will disappear entirely from large areas of its range in the next fifty years, and will be on the verge of extinction by 2100.

Diminishing ice cover is directly tied to the survival of the polar bear. Bears rely on ice from which to hunt seals—their main prey. The analysis done by the USGS projects that in three of the four ice eco-regions of the Arctic, it is most likely that the bears will be eliminated by 2100. In the fourth region, the modeling projects almost even odds that the bears will be somewhere between retaining a small population to being extinct, but it appears that even a small population may not be enough for sustaining the species beyond 2100.

The disturbing quality of the USGS analysis is that their models were derived from statistical projections that have not predicted as steep a decline of actual ice loss as has occurred in the Arctic. In other words, the modeling of polar bear populations assumes more ice extent than the real world is actually producing. Further, there was no accommodation to the modeling made for the consequences of other environmental factors that may occur if the world begins to extract more resources from the Arctic and if a Northwest Passage becomes a reliable shipping route. Such activities would have a further negative effect on a remaining polar bear population.

The second event that has received widespread attention has been the report that the melt of Arctic sea ice set a record for a new summer minimum. The National Snow and Ice Data Center (NSIDC) announced on October 1 that the "Arctic sea ice during the 2007 melt season plummeted to the lowest levels since satellite measurements began in 1979." The NSIDC lead scientist, Mark Serreze, commented that "The sea ice cover is in a downward spiral and may have passed the point of no return. As the years go by, we are losing more and more ice in summer and growing back less and less ice in winter. We may well see an ice-free Arctic Ocean in our lifetimes. The implications for global climate, as well as Arctic animals and people, are disturbing." There has not been an ice-free summer in the Arctic in one million years.

Diminishing bears and sea ice are only the most widely reported aspects of a warming Arctic. Global climate scientists worry about "tipping points"—environmental processes

that could lead to rapid and irreversible changes in the overall global climate or in sea level rise. The Arctic contains several potential sources of a tipping-point in the boreal forests, the albedo effects of melting ice and, one of the most worrisome, permafrost.

Tipping Points in the North

The Arctic permafrost acts as a kind of frozen locker in which carbon is stored. These frozen soils, as well as frozen peat, extend over large areas of North America and Siberia--perhaps as much as 80% of the area. Much of the infrastructure of Russia, Alaska, and the Canadian North is built on permafrost. With thawing of permafrost, some of which extends more than 100 feet in depth, subsidence occurs; peoples' homes, roads, and pipes all could be damaged or destroyed. As disturbing as these consequences are, from a global perspective there is a more profound result: thawing permafrost release stored carbon as either carbon dioxide or as methane.

Estimates of the total stored carbon in Arctic soils are in the range of one thousand gigatons. (See Zimov, Schuur, Chapin III, "Permafrost and the Global Carbon Budget," Science Magazine, Vol. 312, 16 June, 2006). No one knows how much is currently being released, though there are anecdotal reports of methane emerging so quickly from pools in Siberia that it keeps ice from freezing in the dead of winter. The Stordalen mire in Sweden has been observed to produce a 22-66% increase in methane emission as the permafrost thawed. (Christensen, et. al., "Thawing sub-arctic permafrost: Effects on vegetation and methane emissions," Geophysical Research Letters. V. 31, L04501, 2004).

Work done at the National Center for Atmospheric Research (NCAR) projects that over half of the topmost layer of permafrost (top ten feet) will have thawed by 2050 and as much as ninety percent could thaw by 2100. The analysts worked on this question with an eye to modeling increased water runoff from the permafrost into the Arctic Ocean. Their model did not tackle the question of carbon emissions from thawing permafrost, but they conceded that such releases "may be considerable and the feedback is likely to be positive and possibly large." (Lawrence & Slater, "A Projection of Severe Near-Surface Permafrost Degradation During the 21st Century," Geophysical Research Letters, V. 32, L24401, 2005).

While scientists know that thawing permafrost and the release of carbon stored in its frozen matrix could have an enormous impact on overall greenhouse gas emissions, none of the modeling done for the IPCC takes this feedback mechanism into consideration. Past and present anthropogenic emissions of greenhouse gases may so warm the planet that aggressive efforts over the next thirty years to reduce anthropogenic emissions may not be enough to stop the thawing of permafrost and the release of the enormous stores of carbon in those soils.

Permafrost is not the only potential source of accelerated warming. Another potential source for carbon releases lies in the boreal forests of the North. The region is warming and large areas of North America's Arctic have been subjected to drought. The warmer

weather has made the region more hospitable to insects that have attacked the massive conifer boreal forests. In the Province of British Columbia, Canada, pine beetles have become an "epidemic." As of 2006, the beetles had destroyed $6 billion worth of trees and the provincial government began pushing a massive logging increase to try to get ahead of the insect-driven losses. It is estimated that B.C. alone contains almost 7% of the world's softwood. As a researcher at the Pacific Forestry Centre in Victoria, Allan Carroll, puts it, "There's no question [the pine beetles] range has expanded over the last 30 years due to ameliorating climate… " (Webster & Cathro, "Bitter Harvest: Pine Beetle Infestation in B.C.," Canadian Business, January 2006).

Insect weakened, dry trees are subject to fire. This past summer saw the largest forest fire ever witnessed on Alaska's North slope. On July 16, 2007 lightning started a fire that was still burning in the first week of October. It had consumed more than a quarter of a million acres of forest during its run and the smoke plume could be seen from 50 miles away. Scientists in Alaska are concerned that the fire may have damaged the permafrost beneath the forest, causing deeper thaw. As these trees burn, and others succumb to drought and insects, carbon is released into the atmosphere. The loss of trees to store carbon and the release of carbon from dying forests is a potentially important source of greenhouse gases. (Hopkin, "Alaskan Fire Damages Permafrost," Nature, published online 9 October 2007).

Finally, the change in albedo in the North could have an important impact on overall global temperature. As snow and ice melt they reveal the darker earth and ocean. The overall color of the planet's surface directly affects how much solar energy is absorbed by the planet and how much is reflected back out into space. Being darker, the sea will absorb more solar energy, warming the seas and accelerating the melting of the ice. A similar process happens on land that would traditionally be covered by snow. (Note that the loss of boreal forests may have a small negative feedback by revealing a lighter ground under the dark trees—thus reflecting marginally more solar energy back into space than the forests).

Any of these processes that either cause the earth to absorb or retain more solar radiation will add to the overall warming of our atmosphere. If the atmosphere warms enough to reach a tipping point on the ice sheets of Greenland or Antarctica, the consequences for coastal communities and the world economy would be devastating. Scientists do not fully understand the dynamics of ice sheet melting, but it is not a simple linear process where a certain temperature produces a certain rate of melt. Rather there are feedbacks in the melting of the sheets that suggests an exponential or accelerating reaction occurs when melting begins. If the ice sheets of Greenland and Antarctica were to both melt, it would increase the sea level by approximately 200 feet. Experts believe that such an event is extremely unlikely. As one of our witnesses will testify, it is expected that increases in sea level will not occur so rapidly as to raise sea level at the rate of meters over coming decades. However, because the physical dynamics of ice sheet melting are not well understood, they were simply left out of the IPCC's most recent projections of sea level rise in the 21st Century. We currently have no reliable, comprehensive

projection of sea level rise due to this gap in our understanding of ice sheet dynamics in conditions of warming.

A Modest Proposal for Action

The Center for Biological Diversity will appear to provide some advice on steps that can be taken to reduce warming, with particular emphasis on their efficacy in the Arctic. Among the steps they advocate are programs to reduce methane emissions and "black carbon." Black carbon is soot that, in the Arctic, has a particularly pernicious effect. When it is deposited on snow and ice it decreases its reflectivity and increases its heat absorption leading to greater melting. As the Arctic comes under more and more industrialization with other warming, one could anticipate further production of black carbon. Methane is a powerful greenhouse gas, with an estimated global warming potential 23 times greater than carbon dioxide over a 100-year time frame. Methane is a precursor to tropospheric ozone. In that form, it traps shortwave radiation as it enters the earth's atmosphere from the sun and then when it is reflected back again by snow and ice. As a consequence, its impact is strongest over the poles. Reducing global methane emissions would provide a particular benefit to the Arctic.

Witnesses

Dr. Sue Haseltine is the Associate Director for Biology at the U.S. Geological Survey, U.S. Department of Interior and will make a presentation of their findings regarding the future of the polar bear.

Ms. Kassie R. Siegel is the Director of the Climate, Air and Energy Program at the Center for Biological Diversity. She will present their preliminary plan for the mitigation of methane emissions.

Dr. Richard Alley, Evan Pugh Professor of Geosciences at Pennsylvania State University, appeared before the Committee to testify about the findings of the IPCC report earlier this year. He will testify about matters including sea ice, albedo and ice sheet melting. He can also answer questions regarding what factors have and have not been included in IPCC modeling on the climate.

Dr. Glenn Juday is a Professor at the School of Natural Resources and Agricultural Sciences, University of Alaska at Fairbanks, one of the worlds leading centers for the study of the Arctic. He will testify regarding both permafrost—what we do and do not understand about its potential release of carbon—and the boreal forests.